

What is claimed is:

1. A method for producing a nanostructure with a specified diameter or cross-sectional area, comprising:
 - specifying the diameter or cross-sectional area of the nanostructure;
 - selecting a mesoporous siliceous framework having pores with a pore size that has a predetermined dimensional relationship with the diameter or cross-sectional area of the nanostructure, said mesoporous siliceous framework containing metal ions dispersed in substitutional sites and forming a source of catalytic sites; and
 - contacting, in a reactor, the mesoporous siliceous framework with a reactant at a temperature sufficient to produce the nanostructures with the specified diameter or cross-sectional area.
2. The method of claim 1, wherein the siliceous framework comprises a structure selected from the M41S class of materials.
3. The method of claim 2, wherein the M41S class of materials comprises MCM-41 or MCM-48.
4. The method of claim 1, wherein the predetermined pore size is between 1.5 and 20 nm.
5. The method of claim 1, wherein the predetermined pore size is between 1.5 and 4 nm.
6. The method of claim 1, wherein providing the siliceous framework includes adding a surfactant of a predetermined size to an aqueous solution containing a source of silicon and the metal ion.
7. The method of claim 6, wherein the size of the surfactant correlates with an alkyl chain length.
8. The method of claim 6, wherein the pore size correlates with the size of the surfactant.

9. The method of claim 6, wherein the surfactant comprises $C_nH_{2n+1}(CH_3)_3NX$ with $n = 10, 12, 14, 16$ and 18 , wherein X comprises an anion.
10. The method of claim 6, further comprising adding an anti-foaming agent to the aqueous solution.
11. The method of claim 1, wherein the metal ions are selected from the group consisting of Ti, V, Cr, Mn, Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, and mixtures thereof.
12. The method of claim 1, and further comprising changing a concentration of the metal ions in the substitutional sites of the siliceous framework independent of the pore size in the concentration range of the metal ion between 0.01wt\% to 10.00wt\% .
13. The method of claim 1, and further comprising changing a concentration of the metal ions in the substitutional sites of the siliceous framework independent of the pore size the concentration range of the metal ion between 0.10wt\% to 10.00wt\% .
14. The method of claim 1, wherein the reactant comprises a volatile carbon-containing molecule.
15. The method of claim 14, wherein the carbon-containing reactant comprises CO.
16. The method of claim 1, wherein the nanostructures are carbon nanostructures produced by disproportionation of CO.
17. The method of claim 6, and further comprising maintaining a pH value of the aqueous solution between approximately 10.0 and 12.0.
18. The method of claim 6, and further comprising maintaining a pH value of the aqueous solution between approximately 11.25 and 11.75.
19. The method of claim 6, wherein the source of silicon comprises a colloidal silica solution.
20. The method of claim 6, wherein the source of silicon comprises HiSil-915.

21. The method of claim 6, wherein the source of silicon comprises Cabosil L - 90.
22. The method of claim 1, and further comprising reducing the catalyst with a reductant in a temperature range between 300°C and 900°C before contacting the siliceous framework with the reactant.
23. The method of claim 22 wherein the reductant is hydrogen.
24. The method of claim 22 wherein the reductant is hydrogen and the reduction temperature is between 500°C and 700°C.
25. The method of claim 1, wherein the nanostructures comprise nanotubes having open ends.
26. The method of claim 1, wherein the nanostructure comprises nanotubes and at least one of a concentration of the metal ions and the pore size of the mesoporous siliceous framework is adjusted so as to control an electronic characteristic of the nanotubes.
27. The method of claim 26, and further comprising doping the nanotubes with boron or nitrogen to control the electronic characteristic of the nanotubes.
28. The method of claim 26, wherein the electronic characteristic is one of metallic and semiconducting.
29. The method of claim 1, wherein the nanostructures comprise single-wall nanotubes (SWNT).
30. The method of claim 1, wherein the nanostructures comprise multi-wall nanotubes (MWNT).
31. The method of claim 1, wherein the metal ions in the pore are reduced by a reductant to form catalytic sites, with a radius of curvature of the pores controlling reducibility of metal ions in the pore walls.

32. The method of claim 1, wherein the metal ions in the pore are reduced by a reductant to form catalytic sites, with a radius of curvature of the pores controlling both reducibility of metal ions in the pore walls and a size and structure of the catalytic sites.

33. A catalytic framework suitable for growth of nanostructures with a preselected diameter or cross-sectional area, comprising a mesoporous siliceous framework having pores with a pore size and a radius of curvature, and metal ions dispersed in substitutional sites of the mesoporous siliceous framework, wherein the metal ions form a catalytic site when contacting a reactant at a temperature sufficient to produce the nanostructures, with a size of the catalytic site determined by a quantity of metal ions in the mesoporous siliceous framework and the radius of curvature.

34. The catalytic framework of claim 33, wherein the metal ions are selected from the group consisting of Ti, V, Cr, Mn, Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt, and mixtures thereof.

35. The catalytic framework of claim 33, wherein the metal ions dispersed in the substitutional sites are the only source of the metal ions that form the catalytic site.

36. The catalytic framework of claim 33, wherein the nanostructures comprise carbon nanotubes.

37. The catalytic framework of claim 33, wherein the carbon nanotubes comprise single-wall nanotubes or multi-wall nanotubes, or both.

38. Nanostructures having a specified diameter or cross-sectional area produced with the method of claim 1.